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ABSTRACT

A method for forecasting the number of college graduates in the United Kingdom is described, and suggestions are offered about ways that society should react to influence declining enrollments and potential reductions in technologically skilled graduates. Consideration is given to the implications of recruiting noncollege-bound individuals to pursue college studies in specific fields to help relieve shortfalls of workers. The college student recruitment and reporting process used in the United Kingdom is explained, and the specific case of eligible students versus entrants in the field of electrical and electronic engineering in Great Britain universities is addressed. The importance of anticipating demands for engineers is emphasized. It is noted that the problem for industry is the long lead times involved: the attractiveness of employment in a field such as engineering should be demonstrated at least 4 to 6 years in advance of labor needs. (SW)

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PLANNING RESPONSES TO DEMOGRAPHIC CHANGE

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This paper was presented at the Twenty-Sixth Annual Forum of the Association for Institutional Research held at the Marriott Orlando World Center, Orlando, Florida, June 22-25, 1986. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum Papers.

Ann K. Dickey, Chair
Forum Publications Editorial
Advisory Committee

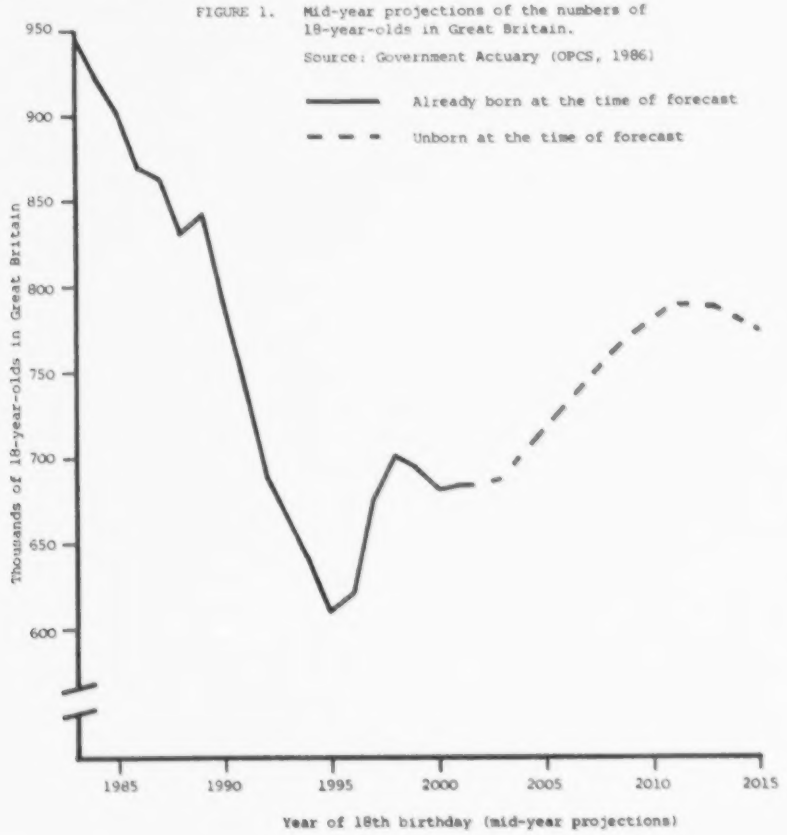
ABSTRACT

The U.K. faces a decline in the 18-year-old cohort from 900,000+ in the mid-1980s to 600,000+ in the mid-1990s. Will a third of the universities close? More importantly will industry and commerce cope with the potential reduction in skilled manpower production? A method is described for forecasting graduate numbers and their quality by discipline, and suggestions are made about ways in which society should react so as to influence unacceptable trends.

INTRODUCTION

The last World War was followed by a baby-boom in the combatant countries and those babies have now generated their own boom of 18-year-olds. As a consequence, higher education in Great Britain has reached a watershed which will have a significant effect upon society beyond the turn of the century. From now until 1995 the size of the 18-year-old cohort declines, slowly at first but then the decline rapidly accelerates. In 1982-83 there were about 940,000 18-year-olds in GB, which number drops to about 610,000 by 1995. The trend is illustrated in Figure 1. The seed corn for higher education drops by a third - will this mean the closure of one institution in three, or one department in three? This topic has been explored in greater depth in Taylor (1982) and it is not relevant to this paper.

FIGURE 1. Mid-year projections of the numbers of 18-year-olds in Great Britain.
Source: Government Actuary (OPCS, 1986)



The changing size of the 18-year-old cohort was researched by a Conference of University Administrators (CUA) Working Party which produced authoritative forecasts of the consequences for higher education (CUA, 1977, 1978). At the same time other interested parties were producing their own forecasts (e.g. Association of University Teachers (AUT), 1977) with varying levels of optimism about the future - and with varying levels of partiality in support of their constituents! The CUA (1978) forecast is illustrated in Figure 2.

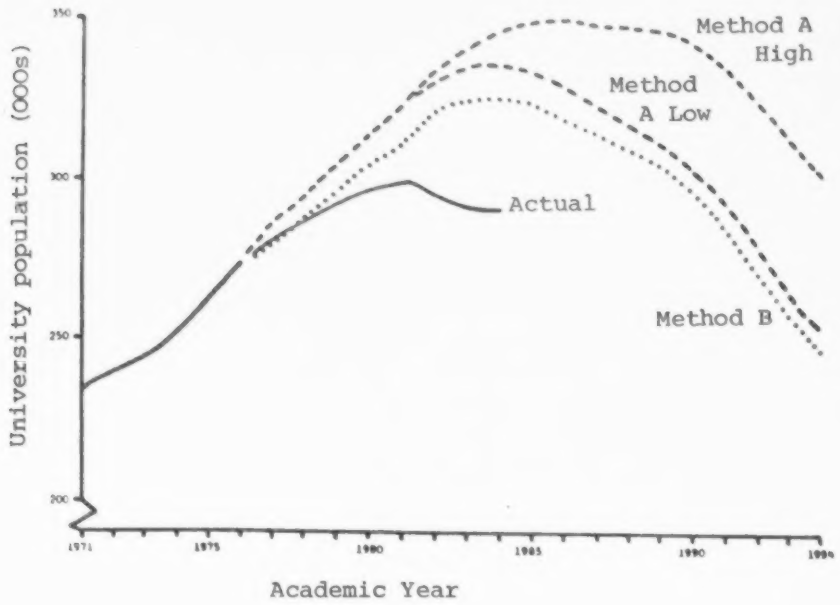


Figure 2. Projections of full-time student numbers in GB Universities 1977-1994 by CUA (1978) compared with actual.

Two methods were used by the CUA to forecast student numbers up to 1994. Method A built up entry cohorts based upon the then current age distribution of UK undergraduate entrants, taking into account numbers 'dropping out' before the completion of their studies. The high projection assumed that the overall age participation rate for higher education would rise to 18% by 1981 and remain at that level. The low projection assumed that the age participation rate would rise to 14.5% and remain at that level.

Method B derived a weighted running mean of participation in the age groups represented in university populations and it distinguished participation differences between men and women. As can be seen from Figure 2, Method B produced a more pessimistic forecast of university populations. The CUA forecasts for 1987-88 were 322,000-347,000 (Method A) and 314,000 (Method B). The AUT (1977) forecast for that year was 363,000. It is salutary that the 1984-85 full-time population of GB universities had already dropped to 290,611 and the reality is illustrated in Figure 2. Forecasts return from time to time to haunt their authors!

The CUA forecasts were accepted as carefully researched but they gave the wrong message, not necessarily the wrong answer. It was suggested (Taylor, 1982) that the decline in higher education would be the equivalent of the closure of one medium-sized university per year for fifteen years. In 1981 student population targets were reduced by Government and the University Grants Committee consistently with that rate of shrinkage. Currently the university system is facing a reduction in recurrent resources which is likely to maintain the decline.

From the viewpoint of the 18-year-old, his opportunity for higher education is diminishing slightly because government-provided support is shrinking faster than demand for admission.

More importantly from society's point of view, a reduction of entrants results in a reduction in the numbers of graduates providing the skills needed by an increasingly technological age. Medicine and hygiene are having a profound effect on the age structure of the population - society is becoming geriatric in its balance, and at the other end of the life span, Figure 1 suggests an increase in the numbers of young persons.

In short, the numbers in the population offering the skills necessary for wealth creation are in a cumulative decline, whereas the numbers in the population dependent on the wealth creation are increasing.

One resolution of the problem is to increase the age participation rate but this would demand the diversion of more of the gross national product to encourage the participation. Alternatively society may be able to influence a larger proportion of those who do participate to opt to pursue studies in the relief of shortfalls of expertise.

This latter alternative is the likely option in a market-driven economy. This paper explores the implications of such a course, given the long lead-times associated with higher education, which separate cause and effect by several years.

What can we deduce about the future? Any forecast is going to be

wrong in detail but the size of the error can be limited by maximising the fidelity of the current informational backdrop against which the forecast is made.

SELECTION OF HIGHER EDUCATION IN THE UK

In the UK we are fortunate in having a wide variety of valuable statistical sources and, equally importantly, recruitment from a national constituency channeled through a central agency which monitors the process.

The forty-five British Universities, funded by government, compete with each other for students, but they tend to compete reactively. Advertisements to attract undergraduate students are rare - and may indicate institutional vulnerability. It has been axiomatic that a university worth its salt will have more candidates for admission than it can possible accommodate. A potential student from anywhere in the country can seek admission to any university offering the subject of his choice. The universities tend to react to the size of the popular demand - any spare resources will tend to be diverted to those subjects in most popular demand. In other words, the shape of higher education tends to be fashioned by school leavers and their advisers and not by any considerations of manpower planning or social needs.

The intending student applies through the Universities' Central Council on Admissions (UCCA). UCCA was established in 1961 to ease the responsible selection of universities by candidates and to allow each university to select its own students. Before 1961 it was something of a 'free for all' with the possibility of every student applying to

every university offering the subject of his choice. The candidate can now select a degree course in each of up to four universities. A standard application form (including a school reference, unseen by the candidate) is sent to UCCA, which acts as a clearing house. The single application form is photostatted and sent to the admissions officer of each of the selected universities. The applicant has to list the four universities in order of preference, although he can bracket them to limit the interpretation. It is somewhat daunting for a university to see itself placed fourth in ranking on the majority of forms.

The university has the task of selecting the best candidates, bearing in mind the seeming quadruplication of people. There are four times as many apparent candidates as there are actual bodies seeking admission to the system as a whole. Add to this the fact that only about 50% of all candidates nationally are actually qualified, willing and able to enter universities when the time comes - hence there can be eight 'apparent' entrants for every real entrant.

The two other factors which obfuscate the selection process are: firstly, the candidate applies for entry <u>before</u> he has any school-leaving examination results to support his candidacy. Secondly, as mentioned above, the admissions officer may see his own degree course in third or fourth place on the list - how does the student view it? He would rather go to his first or second choice university - if he is not accepted by either of them, may he still be a worthwhile student? Could he be a better student than those placing the university as first choice? Why not indeed - the first two choices may be Oxford and Cambridge so the university placed third in the ranking may still feel pleased with itself!

The school-leaving examination in England and Wales is known as the Advanced Level General Certificate of Education (A-level GCE). It is taken as a finale to two years' study between 16 and 18 years of age and is highly specialised and concentrated. Most candidates take A-level GCEs in three subjects - say Chemistry, Physics and Biology. There is a leavening of other subjects at a much lower level but the intensity of specialisation is a criticism of the English educational system and changes are imminent to broaden the syllabus.

The schoolchild tends to focus on a career pathway at the age of fourteen or fifteen if a university course is entailed. In the UK only about 7% of the relevant age group participates in university education and another 5%+ go to polytechnics and it must be wrong to allow the educational qualification system to be dominated by the needs of such a small minority.

So the school child wishes to become, say, a veterinarian. He seeks A-level GCE passes in Chemistry, Physics and Biology and his final two years at school will be heavily dominated by these studies.

The examination results are graded in each subject as A, B, C, D and E as passes and F as fail. A grade to E grade can be scored as 5, 4, 3, 2 and 1 points. Hence a student with A-grades in all three subjects has a 'score' of 15 points. Suppose the student gets three C grades his score is 9 points.....and so on. The theoretical minimum score for admission to university is two A-level GCE passes, i.e. 2 points, although very few are ever admitted with this minimum score to any university.

A caveat should be entered at this stage in the discussion. A difference of one point, say between a C-grade and a D-grade, is not necessarily the same as the one point difference between an A-grade and a B-grade. Similarly there is no equivalence in points values between differing subjects. A B-grade in a foreign language may be representing something totally difference from a B-grade in Physics. However, A-level GCE grades and their associated points scores are the only quasi-numerical pegs on which to hang recruitment decisions, and they are widely used.

Suppose the department can admit 100 entrants. There may be from 500 to 5,000 applications depending upon the prestige of the department. How does the admissions tutor cope? At this stage in the game few, if any, candidates can offer examination results. Now starts the gamble!

Candidates are made a conditional offer of a place, for example, "If you get better than one A-grade and two B-grades (=13 points) we will admit you to read Byzantine Architecture...." or whatever is the subject. Experience in the department from previous years' recruiting suggests that if 1,000 candidates are made this offer and the usual proportion accept the challenge, about 10% of them will satisfy the conditions and knock on the door for entry at the beginning of the academic year.

If 110 actually turn up with the right qualifications, they will be admitted but in the following year's recruitment process, the conditional offers will be raised to two A-grades and one B-grade. Had the

admissions tutor made his offers too low, say two D-grades, the place would be overrun with students, because the offer forms the basis of a contractual obligation.

This is an oversimplification of a highly complex operation with immense potential for misjudgements and it is amazing that roughly the right numbers of students are recruited each year - in spite of the absence of qualifying examination results during the recruitment exercise.

The entire exercise is monitored meticulously by UCCA, to whom offers and acceptances are reported. At the end of the recuiting season, they publish a synthesis of candidacy numbers and entrants in 76 subject categories. Matching between candidates' desires and offers made is imperfect as might be expected, so UCCA also reports a 'clearing' exercise which mops up at the end of the period so as to fill any vacant places with unsatisfied candidates; e.g. those who have not reached the grades required by the offers they have accepted.

Later on, UCCA publishes an annual Statistical Supplement giving further details, such as the average A-level scores of entrants to each of the 76 subjects...and so on. Recently a parallel organisation has been established to simplify the admission to degree courses in the polytechnics.

The recruitment process, together with the reporting process, has been described in detail because they reveal an analytical potential which has not yet been exploited so as to maximise the satisfaction of social demands for skilled manpower.

THE SATISFACTION OF SOCIAL DEMANDS

It may seem cynical, but it is suggested that the proportion of the population participating in higher education is in large part determined by a perception of the rewards offered by society for that participation. Tribe (1975) highlighted trends in society which progressively reward opportunism and devalue steady hard work and merit. Pissarides (1982) was clear that reward plays a significant part in inducing participation in higher education and Australian investigators (CTEC, 1982) came to the same conclusion.

Kotler and Murphy (1981) were moved to propose that higher education will have to vigorously market itself and Stewart and Dickason (1979) were convinced that a more consumer-orientated higher education would produce great benefit from an institutional point of view. What is the tangible reward for participation in higher education? Although the intrinsic rewards of education are inestimable from a personal and philosophical viewpoint, what about feeding the family?

These considerations may seem irrelevant to this paper, but they are not. The long lead times involved in allowing market forces to regulate the supply and demand of skilled manpower must engender grave anxiety in the UK about the future satisfaction of that demand....and at a time when the demand will become increasingly insistent.

One of the 'sunrise' subjects over the past few years has been electrical and electronic engineering and it is likely to play a highly significant part in the technological development of society over the coming decades.

Table 1 shows the UCCA records for recruitment of UK and European Economic Community students to British universities from 1977 to 1983.

Table 1. Candidate numbers and entry numbers to electrical and electronic engineering in GB universities and the percentage of candidates admitted in the year shown. (Source: UCCA Annual Reports.)

Entry year	1977	1978	1979	1980	1981	1982	1983
'Home' candidates through UCCA (a)	3739	4150	4809	5536	5696	5853	5658
Entrants (b)	2139	2334	2536	2791	2842	2514	2298
(b/a)%	57.2	56.2	52.7	50.4	49.9	43.0	40.6

It will be seen that about 50% of the candidates were admitted. It can also be seen that government-imposed restrictions on universities since 1981 have had the undesirable effect of reducing the numbers of entrants to this important subject. There will be a corresponding decline in the numbers of graduates produced in subsequent years. This is contrary to the stated objectives of the government who wished to swing recruitment towards the sciences and technologies. British universities, however, are jealous of their autonomy and when funds are reduced or when student targets are reduced economies may have to be effected and concentrated in expensive subjects.

As an aside, it should be mentioned that many of the disappointed candidates in Table 1 will have found a haven in the polytechnics or other forms of higher education.

Let us suppose that the Electrical and Electronics industry in the UK can absorb 2,500 graduates per year - how will this demand be

satisfied in future years, given the demographic decline illustrated in Figure 1? Clearly the decline must be compensated for by persuading a larger proportion of 18-year-olds to seek entry to the universities.

The UCCA data are a help in isolating the 'drawing power' of subjects among 18-year-olds. In the late 1970s and early 1980s admissions officers saw a steady growth in the numbers of candidates (Table 1) but during the same period the numbers in the 18-year-old cohort were growing. Did the growth in the numbers of candidates represent a real growth in the popularity of the subject or was it due entirely to the growth of the 18-year-old cohort? Figure 3 compensates for the demographic trend by expressing candidate numbers per 1,000 18-year-olds.

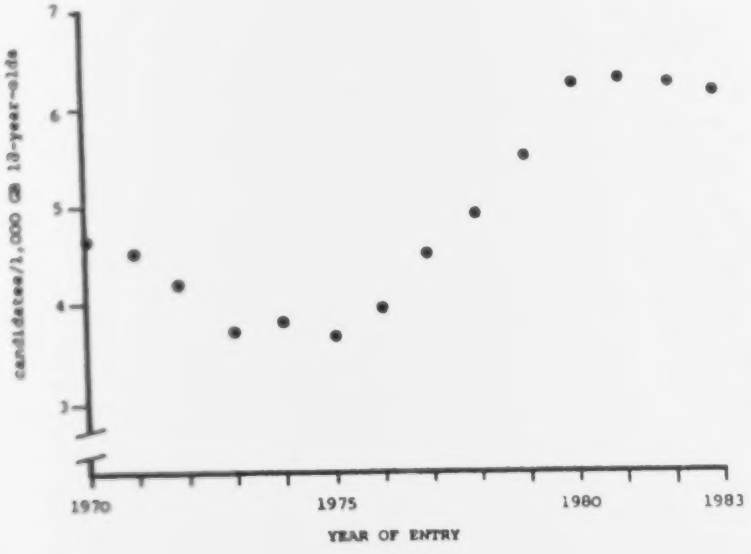


Figure 3. Electrical and electronic engineering candidates for admission through UCCA per 1,000 18-year-olds. (Sources: UCCA Annual Reports, CUA (1978) and Dept. Education & Science, (1983).)

It will be seen from Figure 3 that electrical engineering shared the aversion to the sciences and technologies which was manifest in the mid-1970s. Since then it has become more popular, growing to about 6.2 candidates per 1,000 18-year-olds in the early 1980s.

Another thread which has to be drawn into consideration is the A-level 'quality' of entrants. This begs the question as to whether A-levels measure the quality of what is needed for a good undergraduate, but this is outside the scope of this essay. From the earlier description of the recruitment process it will be common sense that the greater the number of candidates for a fixed number of places, the more selective the admissions process and the higher the quality of the entrants.

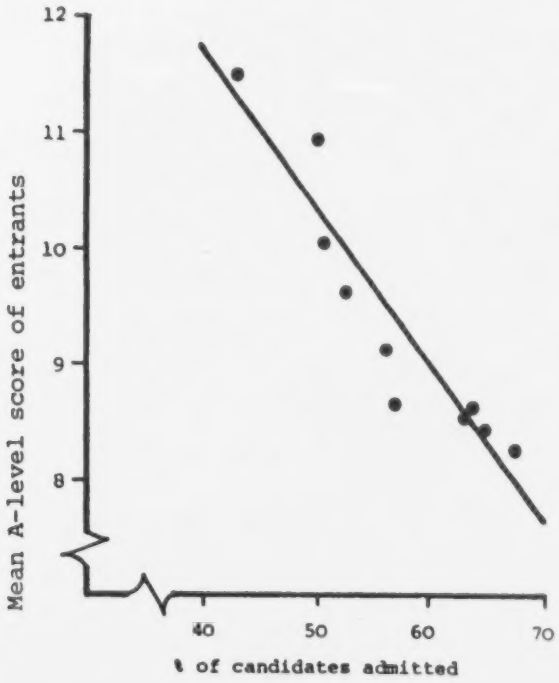


Figure 4. The relationship between the percentage of candidates through UCCA admitted to electrical and electronic engineering and the mean A-level score of entrants. (Sources: Table 1 *supra* for percentages and Universities Statistical Record for A-levels.)

This is exemplified in Figure 4 which shows the relationship between the proportion of candidates admitted and the average A-level score of those entrants. The correlation between the percentage of candidates admitted and the mean A-level score of entrants is very high ($p<0.001$). Almost all of the 76 UCCA subject categories show this relationship as might be expected.

The relationships in Figures 3 and 4 can be coalesced with the forecasted numbers of 18-year-olds shown in Figure 1 so as to give an indication of the recruitment potential in a subject category and also the 'trade-off' between numbers of entrants and their entry quality.

Suppose the capacity and resources of schools of electrical and electronic engineering in British universities are such that they can admit 2,700 undergraduates each year, they will surely do so if possible - even if it means lowering their entry standards somewhat by taking a bigger proportion of candidates. Self-interest will reinforce the 'respectable' argument that it would be wasteful not to use resources to the limit.

The regression equation for Figure 4 (*via* an arcsine transformation to normalise the percentages) is:-

$$\% \text{ of candidates admitted} = \left(\sin\left\{\frac{\text{mean A-level score} - 20.87}{-0.234}\right\}\right)^2 \times 100$$

Hence a mean A-level score of entrants of 9 points implies the admission of 59.9% of candidates. If there is capacity for 2,700 entrants, the actual number of candidates will therefore be:-

Candidates = 2,700 x 100/59.9, which equals 4,508 candidates.

Suppose that this relates to an entry year in which there will be approximately 638,000 18-year-olds in Britain, there will need to be:-

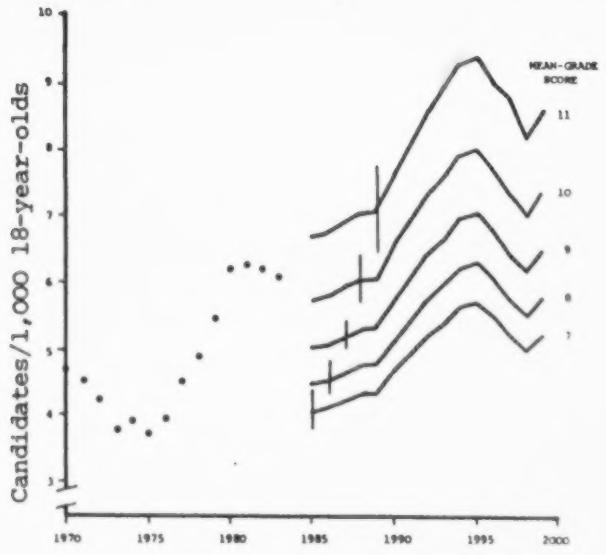
4,508/638 = 7.07 candidates per 1,000 18-year-olds.

As with all regressions, there is uncertainty and the 95% confidence limits are from 6.8 to 7.36 candidates per 1,000 18-year-olds.

Over the last few years, the mean A-level score of entrants to electrical and electronic engineering has been better than 11 points. The argument above sets a lower target for entry quality of 9 points and yet a higher proportion of 18-year-olds than ever before has to be attracted to the subject. By 1995 the throughput can only be sustained by accepting a depression of quality unless a much higher proportion of 18-year-olds than hitherto is attracted to the subjects.

These arguments are used to construct Figure 5, which extends Figure 3 into the future, showing the proportion of 18-year-olds which will have to be induced to become candidates for the subject so as to yield 2,700 entrants per year with the given A-level points scores. The vertical lines are the 95% confidence limits.

If the relative popularity of the subject remains at its previous level of 6.2 candidates/1,000 18-year-olds, the future looks gloomy. The present quality of 11+ points scores will rapidly drop through 10 points and by 1995 will be about 8.5 points. Although the industry will have the same throughput of graduates, their quality as measured by A-levels will show a serious decline.



Year of entry

Figure 5. Legend as for Figure 3 extended to forecast the relationship between candidates/1,000 18-year-olds necessary to achieve the five mean A-level scores indicated: assuming 2,700 entrants per year.

DISCUSSION

The problem for industry is the long lead times involved. It will be too late if it reacts only when shortages become acute. It has to demonstrate the attractiveness of employment at least four to six years in advance of its needs. Market forces seem unable to cope with this situation and the indications from this current recruiting year are that the proportion of 18-year-olds opting for electrical and electronic engineering has fallen further.

If the industry needs the output of 2,500 recruits from an undergraduate intake of 2,700 it had better start influencing the trends immediately - and that implies paying much higher salaries

now than are needed to recruit to fill their current vacancies. The market place is not geared to this concept and it seems probable that the current recruitment difficulties of employers will move towards a crescendo. Taylor and Taylor (1984a and 1984b) drew attention to the dangers and although their comments attracted interest, there is no evidence that the warnings were heeded.

There is some transferability among subjects - e.g. physics graduates may fill some of the employment gaps but this cannot disguise the fact that employers are fishing from a finite and shrinking pool. There is a high likelihood of national economic difficulties because of the hysteresis effect between supply and demand for expertise.

Increasingly in schools mathematics and science teachers are being lured to more lucrative employment outside teaching compensating in part for the shortfall so that the reality is masked. This suggests an even bleaker future with generalists teaching mathematics and science. How can they hope to enthuse pupils with the subjects in the way that specialists can? The proportions of school-leavers opting for science-based university training have shown a marked downturn this year (in excess of a 10% drop in applications) so the forecasts for the future are depressing in the extreme.

It is a matter of fact that the 'dependent' proportion of the population is growing and there are ominous indications of a downturn in the production of skilled manpower. This paper set out to quantify the relationships between the satisfaction of manpower demands in electrical and electronic engineering and the likely depression of quality unless there is a marked change in social rewards - the change having to be in anticipation of need rather than being simply reactive.

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